REMARKS

Continued examination of the claims filed in this amendment is respectfully requested under 37 C.F.R. 1.114. Preferred embodiments of applicants' novel method, novel single crystal and novel semiconductor element are claimed in new claims 32 to 33. Addition of new claims 32 to 33 should not prejudice consideration of the original claims 1 to 31. Reconsideration of the rejection of claims 1 to 31 as obvious under 35 U.S.C. 103 (a) over Jones, et al, (US 5,109,586) is also respectfully requested.

I. SPECIFICATION CHANGE

Each reference character used in the drawing should be described in the specification in accordance with 37 C.F.R. 1.84 (n).

Review of the specification indicated that there was no description in the specification that included drawing reference number "9" on figure 1. This drawing reference number "9" was intended to designate the after-heating zone where tempering and cool down take place.

Consequently the paragraph between lines 16 and 21 was amended to state that in some embodiments the apparatus of fig. 1 includes an after-heating zone 9 where the cool down and tempering can take place. For additional basis for this change besides the disclosure in the aforementioned paragraph see the

last two lines of page 7 of the applicants' specification.

For the foregoing reason entry of the change in the aforementioned paragraph in the specification is respectfully requested.

II. NEW CLAIMS 32 AND 33

Claim 32 is a claim for a preferred embodiment of the method of growing a low-stress or stress-poor single crystal with a hexagonal crystal structure, which has a crystallographic c-axis perpendicular to a [0001] surface, in which the single crystal is a corundum crystal, i.e. sapphire or ruby.

Claim 32 includes additional features and limitations from claims 1, 2, 4, 5, and 10 as well as preferred cooling rates from the applicants' specification. Basis for a melt of aluminum oxide (step a) of claim 32) is found on page 13, lines 2 to 3, of applicants' specification. Basis for a corundum single crystal is found in claim 10 and page 14, line 2, of applicants' specification. Basis for the drawing speed range of step c) of claim 32 is found in lines 15 to 20 of page 7 of applicants' specification. Basis for the cooling rate in step e) of claim 5 is found on page 9, line 18, and following of applicants' originally filed specification.

Also USPTO policy regards the mixing of upper and lower limits for disclosed concentration and property ranges for different embodiments acceptable. See M.P.E.P. 2163.05 III. This policy permits replacement of "1750 K" in the subject matter of claim 2 with "1850 K", the inclusion of the drawing speed range in claim 32 in step c), and the inclusion of the cooling rate in step e).

Finally the basis for the claim that the claimed method produces crystals grown in the c) direction that have lower stress values than prior art crystals grown in the conventional m-direction and r-direction is provided by the exemplary embodiments described on pages 16 to 19, especially page 19, of applicants' specification.

Claim 33 is a claim for the single corundum crystal made by the method of claim 32. Claim 33 is a product-by-process limitation, but claim 33 also contains the limitations that the single crystal is a corundum crystal, such as sapphire or ruby, and the limitation that the corundum single of the invention crystal has lower stress values than prior art crystals grown in the conventional m-direction and r-direction.

III. Obviousness Rejection based on Jones, et al (US '586)

Claims 1 to 31 were rejected under 35 U.S.C. 103 (a) as obvious over Jones, et al, (US 5,109,586).

Claims 1 to 31 have not been amended. New method claim 32 has been added and its subject matter is described in section II above. New single crystal claim 33 has been added and its subject matter is described in section II above.

1. *Prima Facie* Obviousness

It is respectfully submitted that claims 1 to 33 are **not** *prima facie* obvious from the disclosures in Jones, et al, because the reference contains teaching of

the opposite from the claimed invention.

Methods of growing low-stress or stress-poor *single* crystals of corundum are claimed in applicants' claims 1 to 10 and 32. Also low-stress or stress-poor *single* crystals and wafers of corundum are claimed in claims 11 to 31 and 33. Applicants' teach that the excellent low stress values in wafers made from their grown corundum single crystals are due to the fact that they are grown by the claimed growing methods of claims 1 and 32 in the c-axis direction. For example, applicants state on pages 6 and 7 of the specification:

> "The invention is based on the knowledge that the so-called anisotropic stress states of the wafer are responsible for deformation of a single crystal made by the Czochralski method and the wafer obtained from it in the conventional m-direction or r-direction during the subsequent temperature treatment. Indeed radially symmetric stresses are built in during growth in the m-direction or r-direction because of the radially symmetric temperature profile in the crystal. However this causes non-radially symmetric stress formation during oblique cleavage of the c-axis oriented crystals. The stress lines extend from one end of the wafer to the other. These anisotropic stress states in the crystal can never completely relax in a tempering process, so that wafer deformations occur in each subsequent temperature treatment process.
>
> These anisotropic stress states are not present in wafers, which are made from single crystals made by the method according to the invention, since the crystals are grown in a radially symmetric temperature field. Of course similar stresses are built into the single crystal because of the axial temperature gradient. However these latter stresses are only rotationally symmetric and surprisingly may be more strongly reduced in the subsequent tempering treatment than the corresponding materials made according to the state of the art."

In other words, the applicants teach that **a necessary condition** for obtaining the best low stress values, i.e. to minimize stresses in the crystals, is to grow them in the c-axis direction and further that tempering is also required when the crystals are grown in the c-axis direction to obtain the best low stress values,

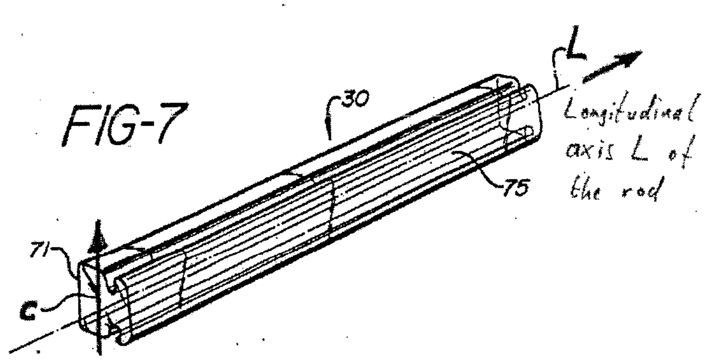
as claimed in claims 1 and 32.

US '586 (Jones) teaches the opposite from the claimed method in applicants' claim 1 in column 5, lines 30 to 54, and thus cannot be used to establish a case of *prima facie* obviousness under 35 U.S.C. 103 (a). Jones, et al, teaches that the direction of crystal growth should be perpendicular to the crystal c axis in order to obtain crystals that have the best low-stress values, i.e. a "minimum amount of strain" in the words of the patentee. For example, in column 5, lines 38 to 44, US '586 states as follows:

> "The minimum amount of strain developed in the growing crystal will occur if the C axis is found in a plane perpendicular to the longitudinal axis L of the rod 30. (See Fig. 7.) This has proven to be the optimum crystal orientation in some cases."

To make it easier to visualize the difference between these growth directions please note the inserted illustration below that shows the prior art situation according to Jones, et al:

FIG-7

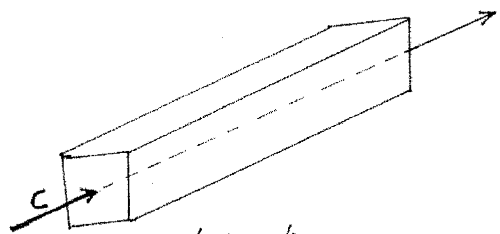


State of the art

c-axis perpendicular to the longitudinal axis of the rod

The c-axis is perpendicular to the direction L in which the crystal grows in the

case of Jones, et al, to minimize stresses according to Jones. However the applicants teach that the <u>strain is minimized or the best low-stress values</u> are obtainable <u>by growing methods in which the single crystal is grown in a direction along the c-axis</u>. The applicants' claimed methods of claims 1 and 32 are limited to growing the crystal in the c-axis direction, which is illustrated below:



Present invention
c-axis <u>parallel</u> to the
longitudinal axis of the rod

The point is not that the method of Jones, et al, is not limited to a particular crystal orientation or that any orientation may be used for their application orthodontic bracket application, which does not have the same critical stress and deformation high requirements as applicants' preferred wafer applications (However if Jones, et al, continues to be cited the location of this teaching in Jones should be pointed out). The point is that Jones, et al, teaches that <u>the lowest, stress values</u> are obtained when the c axis is <u>perpendicular to the growth direction</u>. *This teaching is the opposite from that of applicants.*

It is well established that a prior art reference (and only logical) that teaches doing the opposite from a claimed method cannot be employed under 35 U.S.C. 103 (a) with or without the teachings of another prior art reference to reject the claimed method as obvious. See M.P.E.P. 2145 X. For example, the

Federal Circuit Court of Appeals has said:

> "That the inventor achieved the claimed invention by doing what those skilled in the art suggested should not be done is a fact strongly probative of non-obviousness." in ***Kloster Speedsteel AB v. Crucible Inc.,*** 230 U.S.P.Q. 81 (Fed. Cir. 1986), on rehearing, 231 U.S.P.Q. 160 (Fed. Cir. 1986).

For the foregoing reason alone it is respectfully submitted that Jones, et al, does not establish a case of *prima facie* obviousness of any of claims 1 to 33.

Furthermore the difference in growing direction to minimize stresses in corundum crystals has not been recognized in the reasons for rejection on page 2 of the final Office Action where it states that "the sole difference" is the temperature gradient. The temperature gradient limitation is an important part of the claimed method but it is not the sole difference. The limitation to growing in the c-direction is an essential and necessary condition for obtaining the low-stress values in the product crystals. The tempering and cool down conditions are also important, as claimed in the independent claims 1, 11, 21, 32, and 33.

Second the result-effective parameters are not limited to the heating and cooling parameters including temperature and duration as stated in the final Office Action, but include most significantly the direction of growth, which differs from the conventional growth directions and the preferred growth direction of Jones, et al. Applicants' claims are limited to growth in a particular direction, namely the c axis.

2. Comparative Experimental Results

Experimental results are presented in examples 3 to 5 on pages 17 to 21 of applicants' specification that show that unexpectedly better low-stress values are obtained by the applicants' growth method in which crystal growth of a single crystal with a hexagonal crystal structure, which has a c-axis perpendicular to a [0001] surface, **necessarily** occurs in a direction of the c axis in comparison to prior art methods in which the crystal growth occurs in the r-direction (sample C of applicants' fig. 2) or the m-direction (samples A and B of fig. 2).

The results in applicants' fig. 2 clearly show that the single crystal prepared according to example 3 is unexpectedly more stress-free than any of the prior art single crystals. The three prior art single crystals A, B, and C were obtained commercially as explained on page 19 of applicants' specification. Surprisingly even through the single crystal of the invention was grown in the c axis direction and the prior art single crystals were grown in the m and r direction, the single crystal of the invention had smaller more uniform stress values than those of the prior art. This finding is against the conventional wisdom in the art.

This objective comparative experimental evidence of unexpectedly improved properties for the crystals grown in the c direction according to applicants' claimed method must be considered during examination (MPEP 716.01 (a)) and would overcome any case of *prima facie* obviousness based on Jones, et al, since Jones, et al, describe a method in which the single crystal is

not grown in the c direction like the tested prior art crystals used in the comparative tests of fig. 2. In fact two of the tested prior art single crystals (samples A and B of fig. 2) are grown in the same direction (m-direction) as the crystal according to column 5 of Jones and had considerably higher and more variable stress values.

With respect to the comparative experimental results discussed in the previous amendment the Office Action contends that comparison was not made to the closest prior art because commercial samples were obtained and the method of Jones, et al, was not used.

First this reason for rejection is unfair to the applicants because Jones, et al, have not disclosed the particular details of their method for growing corundum crystals of high strength, such as heat treatment, drawing speed, and tempering temperatures and times. Jones, et al, teach the preferred method of making the alpha alumina rod used to make their bracket is an EFG modification of the Czochralski process described in J. Crystal Growth, **50**, p 8 to 17 (September 1980). See column 4, lines 40 to 51, of Jones, et al. However Jones, et al, also mention several patents by the author of the foregoing article as well as "other patents" (maybe the patents mentioned in the prior art section) without teaching exactly which method was used to make their alumina rod, probably because minimizing stress values is not critical for the orthodontic application.

No examples of a method were provided. Most of the patent involved a description of the orthodontic bracket made from the crystals. Thus there is no disclosure in Jones of the values of critical parameters, like growing speed and

direction, used to growth the corundum crystals with a minimum of stresses.

However comparative crystal sample B obtained commercially was grown according to the Czochralski method (as suggested by Jones, et al, in column 4, lines 40 to 51) and in the m-direction, which is the same as the preferred direction perpendicular to the c-axis described in column 5, lines 29 to 54, of Jones, et al.

Thus according to the limited disclosure of the method in Jones, et al, the comparative crystal sample B whose stress results are shown in fig. 2 of the applicants' disclosure appears to be and must be considered during examination to be the closest prior art corundum crystal according to Jones, et al.

Furthermore an effective comparison of experimental results does not always need to be to what is exactly the closest prior art example in the reference used to reject the claimed invention. In many cases effective comparison to an example that is closer to the claimed invention than the closest prior art example in a reference is also acceptable. See M.P.E.P. 716. (e).

The unexpectedly good results for stress values of the claimed single corundum crystals of the invention shown in fig. 2 in comparison to those for the prior art grown by the same method as in Jones, et al, thus overcome any case of *prima facie* obviousness based on Jones, et al.

For the foregoing reasons withdrawal of the rejection of claims 1 to 31 as obvious under 35 U.S.C. 103 (a) over Jones, et al, is respectfully requested.

Furthermore it is respectfully submitted that new claims 32 and 33 should not be rejected as obvious under 35 U.S.C. 103 (a) over Jones, et al.

Should the Examiner require or consider it advisable that the specification, claims and/or drawing be further amended or corrected in formal respects to put this case in condition for final allowance, then it is requested that such amendments or corrections be carried out by Examiner's Amendment and the case passed to issue. Alternatively, should the Examiner feel that a personal discussion might be helpful in advancing the case to allowance, he or she is invited to telephone the undersigned at 1-631-549 4700.

In view of the foregoing, favorable allowance is respectfully solicited.

Respectfully submitted,

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